INSTRUCTION MANUAL

for the

Model 162
300-INCH f/25
AUTO-COLLIMATOR

MAY 1, 1956

PUBLICATION NO. 162-1236

COPY NO. _____

April 1, 1957

GK/LK:

Attached is a copy of the instruction book for the 300 inch collimator which you requested this past month.

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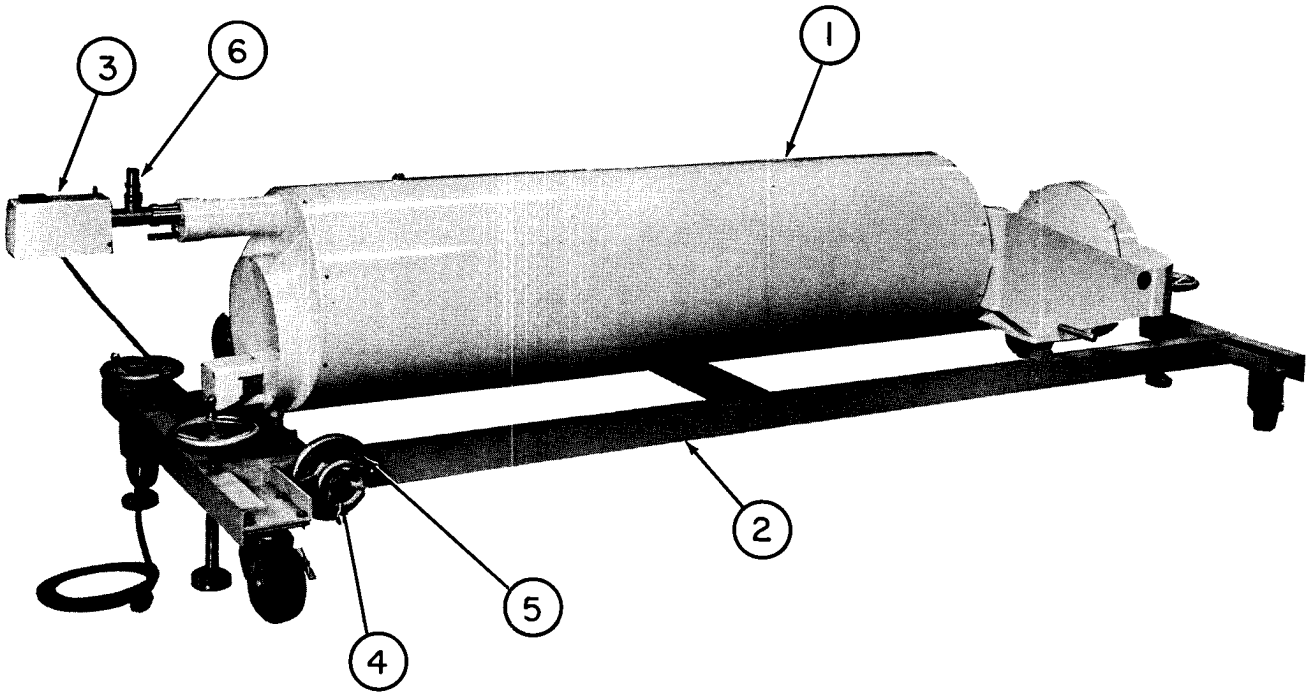


1. Collimator Body
2. Dolly
3. Source Assembly
4. Elevation Jack Hand Wheel
5. Azimuth Hand Wheel
6. Eyepiece

Figure 1. Auto-Collimator, Overall View.

Section I

DESCRIPTION

1. GENERAL

The Model 162 300" Auto-Collimator (shown in Figure 1) is a precision-built optical instrument designed for the collimation of light from various pin hole and resolution targets. The auto-collimator employs an off-axis optical system to contain the folded 300-inch focal length path. An 11-inch aperture is used in this system. The returned image may be viewed or photographed (with a Land Camera attachment) through the eyepiece.

2. MAJOR COMPONENTS

The Auto-Collimator consists of the collimator proper and a base. The collimator is mounted on the base by adjustable supports which provide three directions of tilt of 2^{o} rotation each. A bubble level (which approximates the optical axis) is mounted on the top of the collimator for leveling adjustments. The base has a 3-foot support. The use of an independent base permits the collimator to be removed and replaced without disturbing initial alignment with respect to the ground.

The collimator proper includes eye-end optics and adapters for viewing or photographic operations, a source, targets, beamsplitter, collimating optics, auto-collimating flat, and Land Camera attachment. (See Figure 2.)

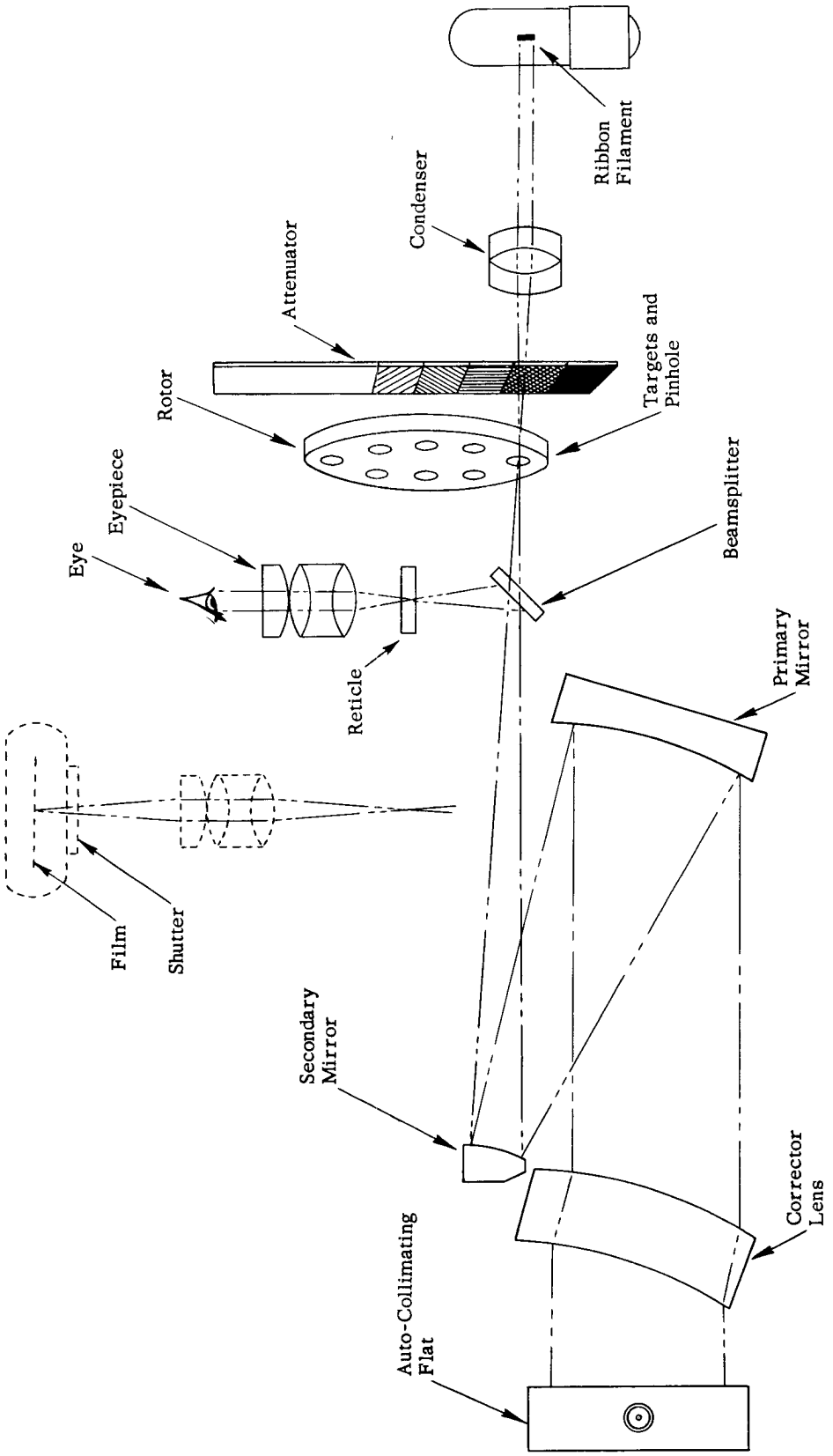


Figure 2. Optical Schematic Diagram.

The source is a 6-volt ribbon filament lamp which illuminates the target over the full 11 inches of aperture. Light attenuation is accomplished by a neutral density step wedge mounted on a slide directly ahead of the condenser triplet. The condenser may be raised or lowered as necessary to image the filament on the target.

Power for the 6-volt lamp is obtained from a 117-volt 60-cps input transformer mounted on the tube. An on-off power switch is installed on the transformer box.

The targets are mounted in a rotor located directly in front of the neutral density slide. Targets are rotated into position by moving the knurled edge of the rotor.

The eye-end adapter tube is translated by a micrometer. A light above the micrometer permits setting and reading the micrometer at night. The light is turned on by a push-button switch.

The beamsplitter, located below the eyepiece, divides the energy for 50-50 transmission and reflection. The rear surface of the beamsplitter is coated to reduce reflection.

The eyepiece is a 20 mm focal length orthoscopic ocular, giving 12.5 microscopic magnification and an overall power of 375. The eyepiece is equipped with a crossline reticle.

The 16 inch auto-collimating flat at the front of the collimator body may be rotated about a horizontal axis. The flat is equipped with a scale calibrated in degrees, a slow motion handwheel which provides vernier control. The line of sight is adjustable from vertical backward to 45^{o}, and horizontal for auto-collimating.

The photographic attachment consists of a Polaroid Land Camera back, equipped with a self-cocking shutter to give 1/10 to 1/200 second exposures, time and bulb exposure settings, and the cable release.

3. TECHNICAL SPECIFICATIONS

Physical Characteristics

Weight

Collimator	260 lbs., approx.
Dolly	230 lbs., approx.

Dimensions

Collimator	124 x 23 x 31 inches (L x H x W)
Dolly	120 x 14 x 40 inches (L x H x W)
Power Input	Nominal 117 volts, 60 cps A. C. .5 Amps.

Optical-Mechanical

Eyepiece

Type	Orthoscopic
Focal Length	20 mm
Overall Power	375 X (eyepiece and collimator)
Microscopic Magnification	12.5 X
Reticle Calibration	Each fine division in the eyepiece reticle subtends an angle of 4 seconds of arc.

Eye-end Adjustment

Type	Micrometer adjustment
Calibration	Calibrated to 0.001 inch
Extent of Travel	Overall travel of 1 inch is provided.

Optical Attenuation	Slide operated neutral density step wedge giving zero to approx. 3 density in 10 steps.
Targets	
Pin Holes	.001, .002, .005, .010 inch diam.
Resolution Patterns	3, 5, 10, and 20 lines/mm
Resolution Target Calibration at other than 300" focal length lenses.	Refer to page 9
Auto-Collimating Flat	
Size	16-inch diameter
Calibration	Scale calibrated in degrees
Adjustments	Direct manual movement through handwheel at eye end of collimator.
Line of Sight	Horizontal for auto-collimating and from vertical to 45^{o} Backward for camera testing.
Camera Attachment	
Type	Polaroid Land Camera, 2 1/4" x 3 1/4"
Shutter Speed of Camera Attachment	1/10 to 1/200 second, T & B
Print Scale	The scale of the Land photograph is 3X the actual visual image since a 3X projection lens is used.

Section II

THEORY OF OPERATION

1. THEORY OF OPERATION

Figure 2 is an optical schematic of the instrument. Light from a tungsten filament source passes through a condenser, through a neutral density step wedge attenuator, and is brought to a focus on the target by the condenser. The attenuator reduces the intensity of the light reaching the target, and is set according to the work to be performed. Any target or pinhole may be moved into the optical path by simply turning the target rotor.

Light from the target passes through a beamsplitter and is reflected twice, first from the secondary mirror, then from the large primary mirror to pass out the compensating lens at the front of the collimator. By folding the optical path in this manner a long focal length may be housed in a relatively short tube length, following the design of the off-axis Maksutov Cassegrain reflector.

When the auto-collimating flat at the front of the instrument is perpendicular to the collimator optical path, light is reflected back through the system for auto-collimation. The light strikes the beamsplitter and is reflected to the eyepiece which contains a reticle and the necessary eye end optics. In this position, the observer may check the instrument, focus the eye end optics (by means of the micrometer), select the proper target or pinhole, and set the attenuator.

In checking focus of a camera, a sheet of aluminized reflecting material is placed in the camera in a plane normally occupied by the photographic plate or film. Figure 3 shows a typical camera test set-up. The auto-collimator micrometer is adjusted to give the required variations from collimated light. The optical flat is tilted as necessary to direct light to the camera optics. The target image (target selected by the rotor) passes through the collimator and is re-imaged by the camera optics onto the reflecting material which reflects it back through the camera optics and collimator to the eyepiece. The test camera is then adjusted to focus the returning image on the reticle. The reflected image may be viewed at the eyepiece, or a Land camera back may be mounted in place of the eyepiece to take a photograph of the image for resolution and focus tests. Normally, a photographic check should be made to test focus and resolution. Figure 4 gives resolution in lines per mm at the camera focal plane.

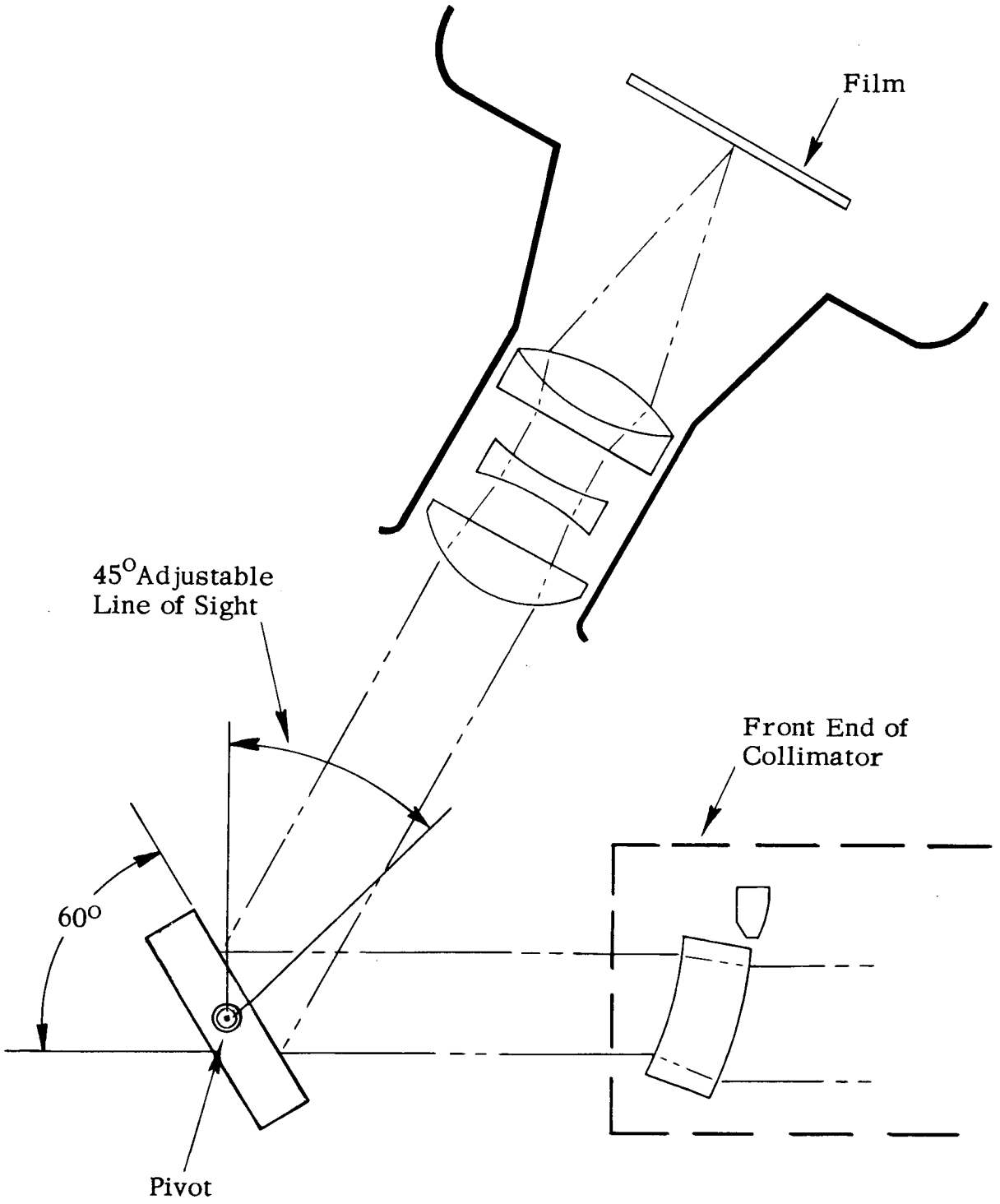


Figure 3. Collimator Set-up For Camera Check.

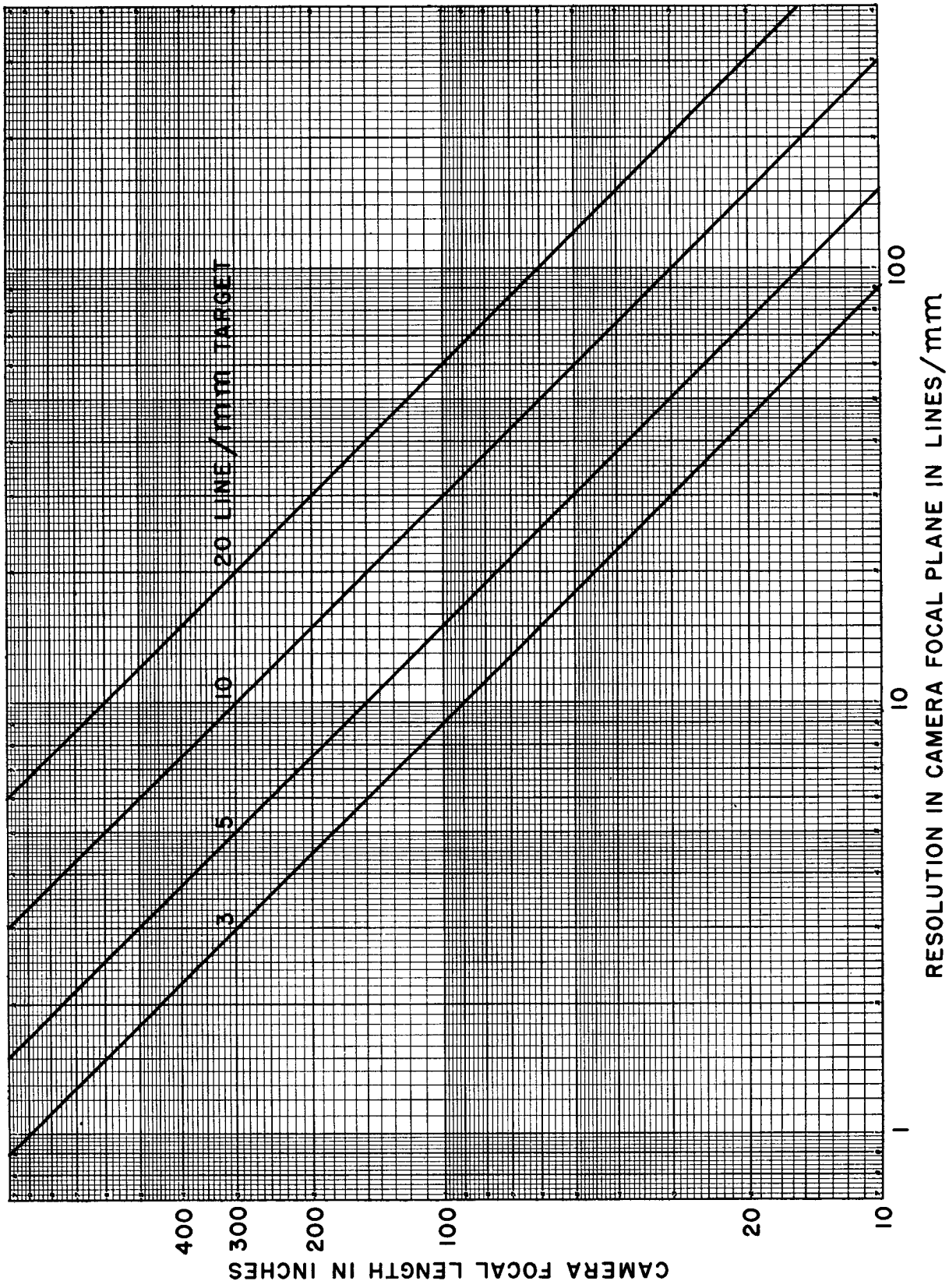


Figure 4. Resolution (L/mm) in Camera Focal Plane

NOTE

The targets, labeled 3, 5, 10, and 20 lines per mm, appear to be of different size at the focus of lenses of other than 300 inch focal length (see Figure 4). The number of lines per mm in the camera focal plane is proportional to the collimator focal length divided by the camera focal length, i.e.:

$$\text{camera lines/mm} = \frac{300}{\text{camera focal length}} \times (\text{lines/mm in collimator target})$$

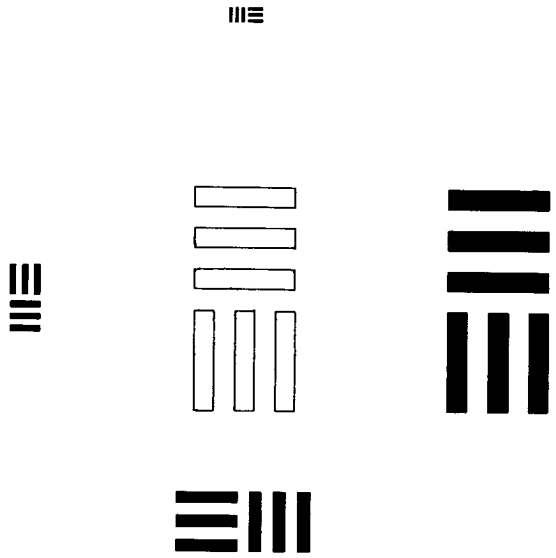


Figure 5. Test and Ghost Images.

It is possible to obtain multiple exposures on one format by rotating the camera attachment about the eyepiece tube. (The image is decentered in the field of view to avoid overlap). Before the Land camera is installed, however, the eyepiece reticle must be adjusted to 45^{o} to avoid having the off-center image fall on the cross lines (see Figure 5). If the film in the Land camera back is overexposed a ghost image may be noticeable, as shown in the center of the recticle in Figure 5. This ghost image in no way affects operation or accuracy. The instrument has been designed so that the ghost image falls outside the primary image and is noticeable only in the event of over-exposure. It is readily distinguished from the direct image even under these conditions and causes no difficulty.

Section III

PREPARATION FOR USE

1. ASSEMBLY

The collimator body is shipped assembled with eyepiece in place. The dolly is packed in a separate box. Supplied with the instrument is the Land Camera attachment, a spare source lamp, and a camel hair brush. Several men should assist in moving the collimator to avoid accidental damage. Always lift the collimator by the handles on the body of the instrument, NEVER by the source housing or eyepiece.

To assemble the collimator to the base, first lay the base on the ground in the approximate position for use. Be sure the ground is clean and level, and not cluttered with stone or gravel. Lift the collimator from its box by the two front lifting handles and mount on the dolly as follows: (1) Seat the rear stud in the jack shaft, (2) place the front left stud in the groove, and (3) lower the front right stud to its surface plate. The optical axis may be adjusted to horizontal by either the dolly jacks or the collimator jack.

2. ADJUSTMENTS

a. Auto-Collimation

With the elevation dial on the flat set at 0^{o}, rotate the elevation control wheel slowly until the image is returned to the eyepiece field. Focus the eyepiece on the eyepiece reticle by sliding it in its tube. Then focus the returned image using the micrometer adjustment.

The collimator is now producing parallel light and the micrometer reading should be noted for future reference, so that it may be reset to this position.

b. Pointing

To point the light path into a system under test, the following procedure is recommended.

1. Set the auto-collimating flat in the general direction of the camera under test, using the elevation dial.

2. Remove the eyepiece and draw tube.

3. Place the eye at the focal point and, viewing the aperture, translate and rotate the collimator in such a manner that the aperture is completely illuminated and any central shadow from the camera is centered on the collimator aperture.

4. Lower the jacks, if not already lowered, so that the collimator is firmly supported.

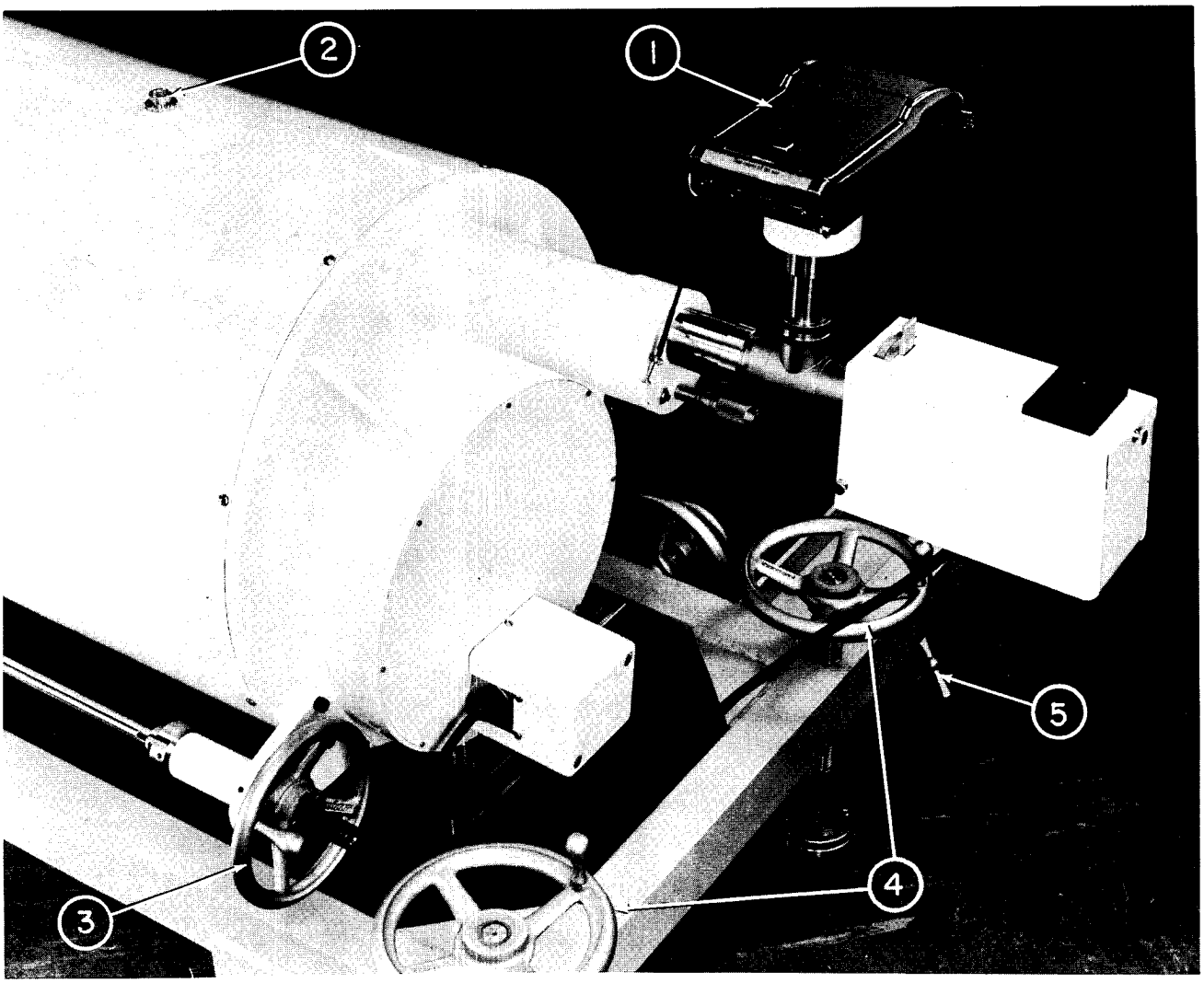
5. Replace the eyepiece and check the image for focus and quality.

c. Photographing

The image photographed will be the image seen through the eyepiece when the draw tube is pushed all the way into the shoulder above the beam-splitter.

Before loading the Land camera with film, set the shutter to the appropriate speed. Exposure may be made with this shutter and cable release or with the shutter in the camera under test (in which case the Land camera shutter may be set at time or bulb). As a starting point, it is suggested that an exposure of 1/100 second at no attenuation be tried (slide all the way in). Since vibrations seriously hamper resolution, exposure should be kept to a minimum. Pola Pan 200 Type 32 Film is recommended. Load camera only after checking iris to make sure it is a wide open.

As stated earlier, the scale of the Land photograph is three times the real visual scale since we are photographing through a 3x projection lens. Consequently, a 10 L/mm target would scale 3-1/2 L/mm on the print.



1. Land Camera
2. Bubble Level
3. Elevation Hand Wheel
4. Dolly Jacks
5. Wheel Brake

Figure 6. Source End Showing Controls and Land Camera.

Section IV

MAINTENANCE

1. LIMITATION OF FIELD MAINTENANCE

The Auto-Collimator is a delicate instrument and should not be handled roughly. The only maintenance that should be performed are periodic inspections for cleanliness, damage, and replacement of bulbs .
Since cleaning of optical elements requires special care, it should be done only by personnel familiar with handling optical elements.

2. PERIODIC INSPECTION

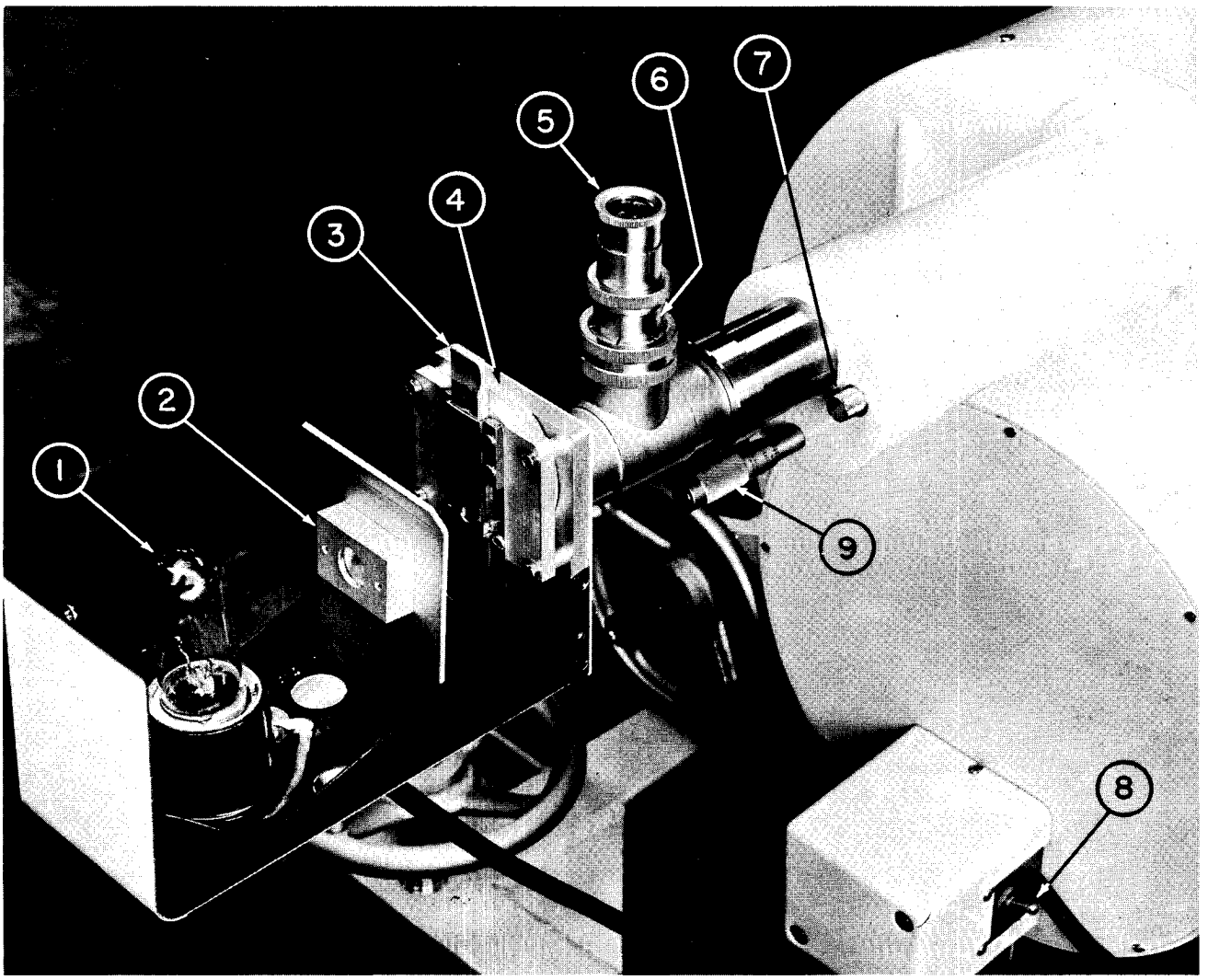
Periodically, make a complete inspection of the instrument. Check for cleanliness of optical components, mechanical action of the optical flat and the micrometer, and operation of the source lamp and micrometer reading lamp. If the optical flat or outside surface of the collimating lens are dirty, refer to the cleaning instructions which follow.

3. CLEANING OPTICAL SURFACES

Periodically check exposed optical surfaces for dust. Clean dust from surfaces with the camel hair brush supplied. Avoid touching optical surfaces with your fingers. If finger marks or oil smudges get on the front-surfaced flat, DO NOT USE THE CAMEL HAIR BRUSH. Prepare a mild solution of liquid detergent and clean distilled water.

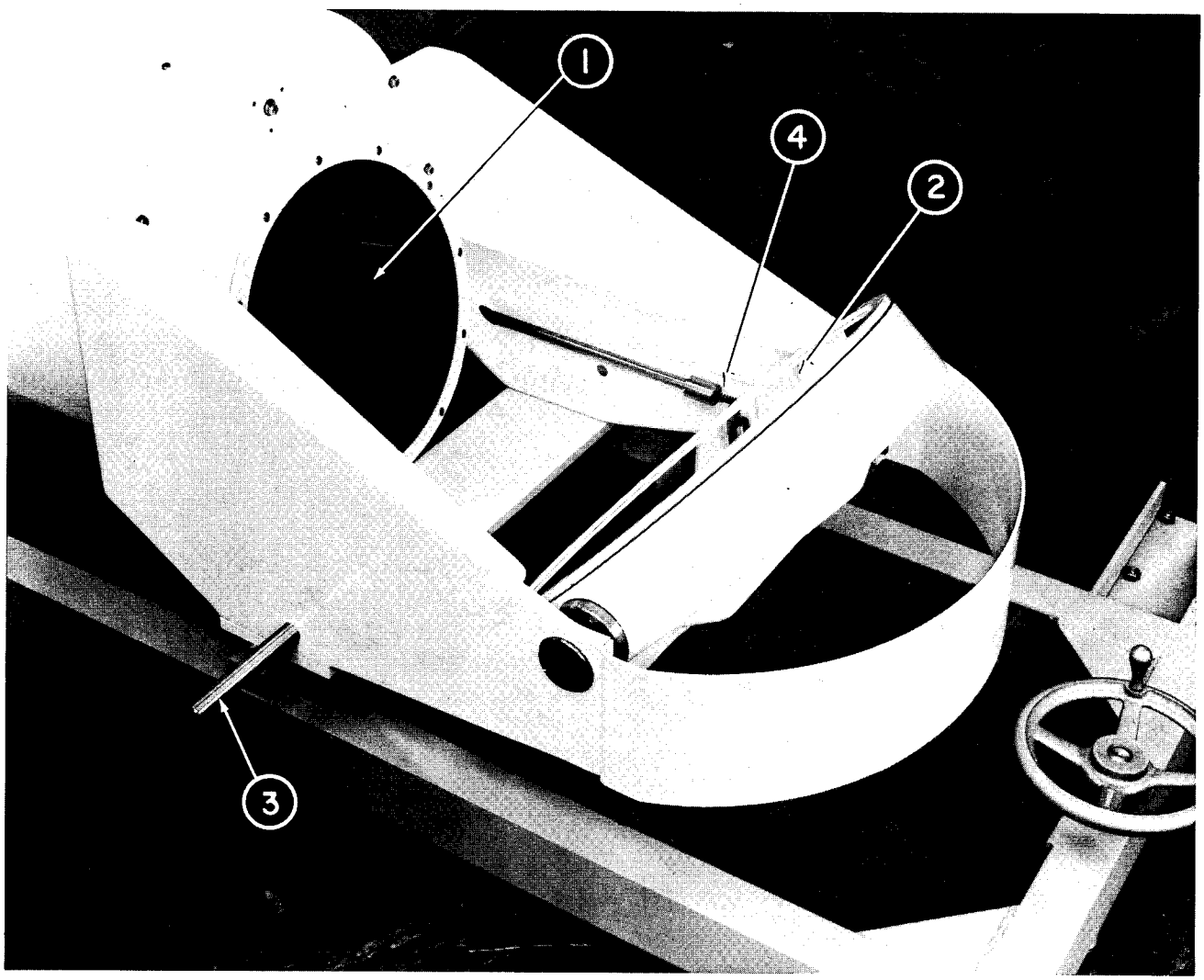
CAUTION

Common non-alkali liquid household detergent will do. Do not use a powdered alkali detergent.



1. Source Lamp
2. Condenser
3. Attenuator
4. Target Rotor
5. Eyepiece
6. Eyepiece Draw Tube
7. Micrometer Lamp
8. Source Switch
9. Focusing Micrometer

Figure 7. Source End Showing Source Assembly and Eyepiece.



1. Corrector Lens
2. Auto-Collimating Flat
3. Handle
4. Elevation Drive Rack

Figure 8. Front End.

Moisten a 1-inch pad of surgical cotton and clean the flat with a spiral motion. When the surface is dry, dampen a clean pad with Methyl Alcohol and repeat the wiping operation. Again, allow the flat to dry. Dampen a clean pad with Acetone and wipe the flat. When the flat is completely dry, loosen any remaining lint with the camel hair brush. Clean only the flat or the outside surface of the large lens at the front end of the barrel. Do not take the collimator body apart. Do not dip the eyepiece or any optical equipment in the detergent solution.

4. REPLACEMENT OF PARTS

a. Micrometer Lamp

1. Unscrew knurled lamp housing. The lamp is fitted into the housing.
2. With a razor blade or similar sharp instrument, pry the lamp from the knurled housing. The lamp is spring loaded and must be pried out.

b. Source Lamp (See Figure 7).

1. Remove the three thumb screws holding the source housing cover in place.
2. Support the lamp socket by placing one hand beneath the socket.
3. The source is a bayonet-type lamp. Press and turn the lamp to remove it.
4. Replace with an equivalent lamp. Be sure to support the source assembly when inserting or removing lamps.

c. Auto-Collimating Flat (See Figure 8).

Replace the flat only if it is badly damaged or scratched. It may only need realuminizing. To remove the flat from its cell:

1. Unscrew retainer ring but leave in place.
2. Place resilient material on the tie plate and below the cell.
3. Turn mirror cell to horizontal position (mirror down) while holding the retainer. Remove the front guard, if necessary, to clear rack.

Section V

REPLACEMENT PARTS LIST

MANUFACTURER'S PART NUMBER	PART NAME
118-0026	Eyepiece
162-0029	Camera Attachment
162-1123	Auto-Collimating Flat
038-8656	Source Lamp
*	Micrometer Pilot Lamp

* Commercial #328 - AN Number AN3140-328